ENGLISH TRANSLATION OF INTERNATIONAL APPLICATION

CELLULAR RADIOTELEPHONE SIGNAL PERMITTING SYNCHRONISATION OF A SUPPLEMENTARY CHANNEL BY MEANS OF A PRINCIPAL CHANNEL AND CORRESPONDING METHOD, TERMINAL AND BASE STATION

Field of the invention

The field of the invention is cellular radiotelephony. More precisely, the invention relates to transmission of data in a radiotelephony system, particularly at high speeds.

Known radiotelephony systems such as G.S.M are dedicated essentially to voice communications. They use a channel comprising two symmetric channels, namely a downlink channel (from an earth base station to a mobile station) and an uplink channel (from the mobile station to the base station).

Systems under development are also based on such a structure. Thus, the UMTS standard defined by the ETSI allows a symmetric distribution between the downlink channel and the uplink channel.

It is also proposed to complete the radiotelephony system by adding at least one supplementary channel to the principal channel, in the down direction only and dedicated to transmission of high speed data such as files transmitted on the Internet network.

Within the framework of this invention, it is assumed that the radiotelephony system is of the type comprising a symmetric two-directional principal channel and at least one supplementary channel like that mentioned above.

It is also assumed that the supplementary channel uses a multicarrier technique assuring distribution of data in time / frequency space and has a sub-frame type structure.

More precisely, the invention relates to a technique enabling synchronisation of the supplementary channel at sub-frame level, in a terminal of a radiotelephony system like that mentioned above.

The invention is particularly but not exclusively applicable to synchronisation of an OFDM HS-DPA supplementary link (supplementary channel) associated with the UMTS principal link (symmetric two-directional principal channel), at sub-frame level.

Solutions set forth in prior art

In order to simplify the situation, the following describes the disadvantages of prior art with relation to this particular application mentioned above. However, it is clear that this discussion could be transposed to other radiotelephony systems including a symmetric two-directional principal channel and at least one supplementary channel.

Remember that the HS-DPA (High-Speed Downlink Packet Access) supplementary link is a high speed downlink associated with a UMTS principal link. It is intended to increase the downlink speed to provide services requiring high speed (multimedia, video streaming, etc.).

As shown in figure 1, the UMTS principal link has a structure organised in N, N+1 frames each comprising 15 slots (time intervals) S1 to S15. As shown in figure 2, the HS-DPA supplementary link has a structure organised into N, N+1 frames each comprising up to 5 sub-frames SF1 to SF5. Moreover, each slot or sub-frame comprises a set of symbols, and each symbol comprises a set of signal units (chips).

For the physical layer of the HS-DPA supplementary link, two technical solutions are suggested:

- a spectrum spreading system conforming with the UMTS system;
- a system based on an OFDM multicarrier modulation.

With the first solution, an UMTS HS-DPA supplementary link is obtained that is inherent to the UMTS system. Therefore, it can benefit from all the techniques already used by the UMTS principal link, such as channel estimation, control of power and clocks, and particularly synchronisation made with the CPICH signal specified in the UMTS standard.

With the second solution, the result is an OFDM HS-DPA supplementary link that uses a modulation different from that used in the UMTS system (spectrum spreading, CDMA). Consequently, it cannot use all techniques used in the UMTS system. Therefore, it must use specific techniques so as to accomplish the same functions. Nevertheless, some adaptation to the context can facilitate setting up and maintaining communication with the OFDM link.

An OFDM sub-frame of the OFDM HS-DPA supplementary link and a UMTS sub-frame of the UMTS HS-DPA supplementary link have the same duration, namely 2 ms, and are interchangeable. The OFDM HS-DPA and UMTS HS-DPA supplementary links may each use a distinct clock (or time base) but their architectures are such that the beginning and end of the OFDM and UMTS sub-frames are identical.

Synchronisation in time is one of the key elements in setting up a communication. This synchronisation is broken down into several "layers" due to the nature of the radiomobile cellular communication system that defines the two entities; sub-frame and frame (see figure 2). Thus, for the HS-DPA supplementary link, this synchronisation is divided into several steps:

- synchronisation at chip level, that consists of finding the position of symbols (and therefore of chips included in these symbols) depending on the clock used;

- synchronisation at sub-frame level, that consists of finding the beginning of sub-frames;

- synchronisation at frame level, that consists of finding the beginning of each frame.

The UMTS HS-DPA supplementary link may be synchronised relatively easily. Since the UMTS HS-DPA supplementary link is intimately linked to the UMTS system, it can be synchronised directly based on the UMTS principal link. Thus, initial synchronisation of the UMTS HS-DPA supplementary link at the chip may be done by a temporal self-correlation on a specific synchronisation signal (PSCH) provided in the UMTS. After acquiring this synchronisation at chip level, the UMTS HS-DPA supplementary link can be synchronised at sub-frame

level by making a search for the beginning of the UMTS slots (knowing that each sub-frame contains a predetermined number of UMTS slots, for example 3). This search is done using the PSCH signal. This signal is in the form of a packet of 256 identical chips sent at the beginning of each slot. Finally, the frame of the UMTS HS-DPA supplementary link is synchronised using the SSCH (Secondary Synchronisation Channel) signal that has the same shape as the PSCH signal except that packets of 256 chips transmitted are modulated by known information. Figure 3 shows the order of the different synchronisation steps of the UMTS HS-DPA supplementary link at chip, slot and frame levels respectively.

On the other hand, synchronisation of the OFDM HS-DPA supplementary link is now more difficult because, unlike the UMTS HS-DPA supplementary link, the OFDM HS-DPA supplementary link is not intimately linked to the UMTS system. According to the current technique, the OFDM HS-DPA supplementary link can be synchronised at chip level using the delay interval that represents a part of the OFDM symbol (the last part). This synchronisation at chip level is obtained by a simple conventional self-correlation on the received OFDM HS-DPA signal. But, once this synchronisation has been done at chip level, it is impossible to know the beginning of the sub-frames and frames because the OFDM signal specified in the HS-DPA frame does not contain the PSCH and SSCH signals necessary for synchronisations at sub-frame and frame levels. According to the existing technique, synchronisation of the OFDM HS-DPA supplementary link at sub-frame level is specific to the OFDM system and is based on insertion of signals specific to synchronisation at sub-frame level. The major disadvantage of current art is that the above-mentioned specific signals increase the load of the OFDM HS-DPA supplementary link.

Purposes of the invention

The invention is intended specifically to compensate for this major disadvantage with the state of the art.

More precisely, one of the objectives of this invention is to provide a new technique to facilitate synchronisation of the supplementary channel of a cellular

radiotelephony system at sub-frame level (particularly an OFDM HS-DPA supplementary link associated with a UMTS principal link).

Another purpose of the invention is to provide such a technique that does not require the addition of signals specific to synchronisation at sub-frame level, or limits it, and maintains the structure initially defined for the supplementary channel.

Another purpose of the invention is to provide such a technique that is easy to implement and inexpensive.

A complementary purpose of the invention is to provide such a technique that does not require previous synchronisation of the supplementary channel at chip level.

Yet another purpose of the invention is to supply such a technique that makes synchronisation of the supplementary channel at frame level easy.

Essential characteristics of the invention

These various purposes and others that will become clear later are achieved according to the invention using a cellular radiotelephony signal of the type including:

- a two-directional symmetric principal channel including a principal uplink channel and a principal downlink channel, particularly for low or medium speed transmission of signalling and control data and information;

- at least one supplementary channel assigned to the downlink only, particularly for transmission of data at high speed, making use of a multicarrier technique for distribution of data in the time / frequency space, and with a sub-frame type structure.

According to the invention, the beginning of at least one sub-frame of the supplementary channel is offset by a time interval with a determined duration not equal to zero (Δt) with respect to a determined time (t_0) on the principal channel, so as to enable synchronisation of the supplementary channel at sub-frame level in a terminal, by detection of said determined time (t_0) and by adding said time interval (Δt).

Therefore, the general principal of the invention is to align sub-frames of the supplementary channel in time with a known reference time (t_0) identified on the principal channel and that can therefore be determined on a terminal (receiver).

The time interval (Δt) and the time (t_0) determined on the principal channel are either known in advance by the terminal (receiver), or are sent to the receiver dynamically through the principal channel (see the different embodiments of the invention discussed in detail below).

In a first advantageous embodiment of the invention, the structure of the principal channel is organised in frames and the determined time (t_0) on the principal channel is a beginning of a frame of the principal channel.

Advantageously, the beginning of each frame of the principal channel forms a determined time (t_0).

According to one advantageous variant, the beginning of only some frame(s) of the principal channel called the synchronisation frames forms a determined time (t_0).

In this variant, the terminal must be able to identify each synchronisation frame among all frames that it receives on the principal channel.

To achieve this, the principal channel and / or the supplementary channel advantageously transmit(s) identification data of at least one synchronisation frame.

In particular, this means that a choice of synchronisation frames is not fixed in advance. However, it is clear that the invention also relates to the case in which the choice of synchronisation frames is fixed in advance, and in which the terminal is informed once and for all.

In a second advantageous embodiment of the invention, it is assumed that the principal channel has a structure organised in frames each including a plurality of slots, then the time (t_0) determined on the principal channel is a beginning of a slot of the principal channel.

Advantageously, the beginning of only some slot(s) of the principal channel called the synchronisation slots, forms a determined time (t_0).

The terminal must be capable of identifying each synchronisation slot among all the slots that it receives on the principal channel.

To achieve this, the principal channel and / or the supplementary channel advantageously transmit(s) identification information of at least one synchronisation slot.

In this way, in particular it is possible to not fix a choice of synchronisation slot in advance. However, it is clear that the invention also relates to the case in which the choice of synchronisation slots is fixed in advance, and in which the terminal is informed about this choice once and for all.

Considering the case in which the principal channel has a structure organised in frames each comprising a plurality of slots, each slot including a plurality of signal units (chips), then the determined duration of said time interval (Δt) is preferably equal to k times the duration of a signal unit, where k is an integer number. Advantageously, this number k is equal to 256.

Advantageously, the principal channel and / or the supplementary channel transmit(s) information about said duration of the time interval (Δt).

In particular, this makes it possible to not fix the duration of the time interval (Δt) in advance. However, it is clear that the invention also relates to the case in which this duration is fixed in advance, and in which the terminal is informed once and for all.

Preferably, the principal channel and / or the supplementary channel transmit(s) information about the rank within a frame of the structure of the supplementary channel, a sub-frame for which the beginning may be detected, so as to enable synchronisation of the supplementary channel at frame level by detecting the beginning of the next frame as a function of said synchronisation at sub-frame level and said information about the rank of said sub-frame.

Advantageously, the principal channel and / or the supplementary channel also transmit(s) information related to the mode of transmitting sub-frames on the supplementary channel, said synchronisation at frame level of the supplementary channel also depending on said information about the transmission mode.

In one advantageous embodiment of the invention, the principal channel uses a spectrum spreading access technique (CDMA) and is preferably a UMTS link. Moreover, for example, said supplementary channel uses a multicarrier technique based on an OFDM modulation or an IOTA modulation.

The principle and use of the IOTA modulation are described in a French patent application FR 95 05455, incorporated herein by reference.

Advantageously, the principal channel firstly transmits a notification prompting said terminal to perform said synchronisation at sub-frame level of the supplementary channel, to swap the terminal from the principal channel to the supplementary channel.

Note that this notification procedure (that preferably uses the paging channel of the principal channel) can be used to start any type of synchronisation procedure at the sub-frame level of the supplementary channel, and therefore also the above-mentioned conventional procedure (in other words based on specific synchronisation signals transmitted on the supplementary channel and not on time interval (Δt) concepts and time (t_0) concepts as in this invention).

Therefore, in the context of this invention, this notification prompts the terminal to detect the determined time (t_0) on the principal channel.

Advantageously, said notification comprises information about said duration of the time interval (Δt) and / or said determined time (t_0) on the principal channel.

Preferably, said notification is transmitted to a paging channel included in said principal channel.

The invention also relates to a synchronisation process for a supplementary channel associated with a symmetric two-directional principal channel, this process using the above-mentioned cellular radiotelephony signal. This process comprises a synchronisation step of the supplementary channel at sub-frame level, itself including the following steps:

- detect a determined time (t_0) on the principal channel;

- obtain the beginning of a sub-frame of the supplementary channel, by offsetting the detected time (t_0) by a time interval with a determined duration not equal to zero (Δt).

Advantageously, said duration of the time interval (Δt) and / or said determined time (t_0) on the principal channel is (are) fixed and known to said terminal.

According to one advantageous variant, said duration of the time interval (Δt) and / or said determined time (t_0) on the principal channel is (are) variable, and the principal channel and / or the supplementary channel transmit(s) information about said duration of the time interval (Δt) and / or said time (t_0).

Advantageously, said method also includes a preliminary step in which a notification is transmitted through the principal channel prompting said terminal to do said synchronisation at sub-frame level of the supplementary channel, so as to swap the terminal from the principal channel to the supplementary channel.

The invention also relates to a terminal using such a cellular radiotelephony signal. This terminal includes means of synchronisation of the supplementary channel at sub-frame level, themselves including:

- means of detecting a determined time (t_0) on the principal channel:

- means of obtaining the beginning of a sub-frame of the supplementary channel, by offsetting the detected time (t_0) by a time interval with determined duration not equal to zero (Δt).

The invention also relates to a base station using such a cellular radiotelephony signal. This base station includes means of offsetting the beginning of at least one sub-frame level of the supplementary channel, by a time interval with determined duration not equal to zero (Δt) from a determined time (t_0) on the principal channel, so as to enable synchronisation of the supplementary channel at sub-frame level, in a terminal, by detection of said determined time (t_0), and adding said time interval (Δt).

List of figures

Other characteristics and advantages of the invention will become clear after reading the following description of a preferred embodiment of the invention given as an informative and non-limitative example and the appended drawings in which:

- figure 1 shows the known structure of a UMTS principal link organised in frames and slots;

- figure 2 shows the known structure of a US-DPA (OFDM or UMTS) supplementary link organised in frames and sub-frames;

- figure 3 shows relations between the three synchronisations of the UMTS HS-DPA supplementary link at chip, slot and frame levels respectively, within the framework of known art;

- figure 4 shows a cellular radiotelephony signal according to a particular embodiment of the invention, in which the reference time (t_0) is the beginning of a frame of the UMTS principal link;

- figure 5 shows relations between the three synchronisations of the OFDM HS-DPA supplementary link at chip, sub-frame and frame levels respectively, within the framework of the technique used in the invention.

Description of an embodiment of the invention

The example considered in the remainder of the description is the case of a cellular radiotelephony signal including a UMTS principal link (symmetric two-directional principal channel) and an OFDM HS-DPA supplementary link (supplementary channel).

The invention defines the characteristics of this signal, used to facilitate synchronisation at the sub-frame level and at chip and frame levels, of the OFDM HS-DPA supplementary link.

Figure 4 shows a cellular radiotelephony signal set according to a particular embodiment of the invention.

A first time axis 41 shows the UMTS principal link. A single frame 42 of this link is shown, in order to simplify the figure. Conventionally (see the

discussion in figure 1 above), this frame 42 includes a plurality of slots (not shown), themselves including a plurality of chips (signal units) 43_1 to 43_N.

A second time axis 44 shows the OFDM HS-DPA supplementary link. A single sub-frame 45 of this link is shown, for simplification purposes. For example, it has a duration of 2 ms. Conventionally (see discussion about figure 2 above), this sub-frame 45 includes a plurality of chips (signal units) 46_1 to 46_M.

In this embodiment of the invention, the frame 42 of the UMTS principal link plays the role of a "synchronisation frame" at the sub-frame of the ODFM HS-DPA supplementary link. This translates the fact that the beginning of the sub-frame 45 of the OFDM HS-DPA supplementary link is offset by a time interval Δt with a determined duration not equal to zero from the time t_0 at the beginning of the frame 42 of the UMTS principal link.

Thus, a terminal that receives this cellular radiotelephony signal can easily perform synchronisation at the sub-frame of the OFDM HS-DPA supplementary link included in this signal.

All that is necessary is for the terminal to detect the start time t_0 of the frame 42 of the UMTS principal link that it receives, and offset this time t_0 by the duration of the time interval Δt (that it knows by assumption), thus obtaining the start time of the sub-frame 45 of the OFDM HS-DPA supplementary link that it also receives.

The duration of the time interval (Δt) may be fixed and known to the terminal. For example, this duration may be equal to 256 chips, which corresponds to a pilot symbol time.

According to one variant, it can be variable and the UMTS principal link transmits information about this duration, so that the terminal can become familiar with it. It would also be possible to plan for this information to be transmitted either by an OFDM HS-DPA supplementary link, alone or in combination with the UMTS principal link.

Similarly, the choice of frames for the UMTS principal link that act as synchronisation frames (in the sense mentioned above) may be fixed and known

to the terminal. For example, all frames of the UMTS principal link are synchronisation frames.

According to one variant, the UMTS principal link transmits identification information of the synchronisation frames. For example, a frame of the UMTS principal link can transmit information indicating that the next frame of the UMTS principal link is a synchronisation frame. It would also be possible for this information to be transmitted by the OFDM HS-DPA supplementary link alone or in combination with the UMTS principal link.

Figure 5 shows the relations between the three synchronisations of the OFDM HS-DPA supplementary link at chip, sub-frame and frame levels respectively, within the framework of the technique used in the invention.

As described above with reference to figure 4, the cellular radiotelephony signal according to the invention can be used to simply synchronise the OFDM HS-DPA supplementary link reference 51 in figure 5, at sub-frame level.

Note that once this synchronisation has been obtained at sub-frame level 51, synchronisation at chip level (reference 52 in figure 5), is also obtained. In other words, there is no need to firstly synchronise the OFDM HS-DPA supplementary link at chip level. Obtaining information at the beginning of a sub-frame of the OFDM HS-DPA supplementary link according to the invention also provides information about the sampling point of the first chip included in the first symbol of this sub-frame.

Optionally, the cellular radiotelephony signal according to the invention also makes it simple to synchronise the OFDM HS-DPA supplementary link reference 53 in figure 5 at frame level, after synchronisation has been done at sub-frame level 51.

This assumes for example that the terminal knows:

- the rank of the sub-frame 45 for which the beginning is detected in the synchronisation step 51 in the sub-frame of the OFDM HS-DPA supplementary link, within an OFDM HS-DPA supplementary frame;

- the sub-frame transmission mode on the OFDM HS-DPA supplementary link. There may be several modes: transmission of all sub-frames, one frame out of three, etc.

The terminal can detect the beginning of the next frame of the OFDM HS-DPA supplementary link, starting from the above-mentioned rank, the above-mentioned transmission mode and synchronisation at sub-frame level.

For example, the terminal can know the above-mentioned rank and transmission mode through the transmission of information related to this rank and this transmission mode, through the UMTS principal link. It would also be possible for this information to be transmitted through the OFDM HS-DPA supplementary link, alone or in combination with the UMTS principal link.

It is clear that many other embodiments of the invention would be possible.

In particular, it would be possible for reference times t_0 to be the beginning of all or only some of the slots of the UMTS principal link.

It would also be possible that the UMTS principal link firstly transmits a notification inviting the terminal to do synchronisation at the sub-frame of the OFDM HS-DPA supplementary link, so that the terminal can change over from the UMTS principal link to the OFDM HS-DPA supplementary link. Optionally, this notification includes information related to the duration of the time interval (Δt) and / or the determined time (t_0) on the principal link.

For example, this notification is transmitted on the paging channel (PICH "Paging Indicator CHannel) included in the UMTS principal link. Remember that the PICH channel belongs to the UMTS system and is composed of 300 bits (b0,...b299) transmitted during the period of a 10 ms frame. The length of the spread sequence used is 256. The last 12 bits (b288,...b299) are not used in the UMTS standard and are therefore free. These 12 bits may for example be used as follows, in order to notify the changeover to the OFDM HS-DPA supplementary link:

- 4 bits for notification of the changeover to the supplementary link (these bits may contain information about the carrier frequency of the supplementary channel);

- 4 bits to indicate the time t_0; this gives 16 possibilities that can indicate any one of the 15 UMTS slots in a frame;

- 4 bits to indicate the time interval Δt.